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*STRUCTURAL CHANGES ASSOCIATED WITH FACTOR MUTATIONS AND WITH CHROMOSOME MUTATIONS IN DATURA*¹

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Communicated by C. B. Davenport, January 14, 1922

The fact has recently been emphasized² that two distinct types of mutation may occur in plants—those which are due to the change of a single factor or gene and those which are due to the addition of one or more entire chromosomes. The Jimson Weed, *Datura Stramonium*, displays both of these mutation types. If we consider the purple-flowered, spiny fruited, many-noded form the primitive type, three “factor” mutations have occurred, giving rise to white-flowered, smooth-fruited, and few-noded types; and twelve distinct “chromosome” mutations have been identified and named, each of which has been found to be associated with the addition of an extra chromosome to a particular one of the twelve pairs. Tetraploid plants and other chromosomal aberrations have also been found.

These mutations have been identified by various external characters. The purpose of the present investigation (of which this paper is a preliminary report) is to study and compare the *structure* of these mutant forms, both as to gross external morphology and as to internal anatomy; and thus to determine the structural effects produced by a single factor and those produced by a single entire chromosome. In this way it may be possible to begin an analysis of the factorial constitution of each of the chromosomes.

Externally, various measurements of the gross structure of the plant body were made. Branching in the Jimson Weed is essentially dichotomous and the two branches are usually of decidedly different lengths. These measurements were of (1) the trunk length (height of stalk to the first fork; (2) the width of the angle formed by the branches at the first

fork of the stem; (3) the width of the angles formed by the branches at the two second forks; (4) the width of the angles formed by the branches at the four third forks; (5) the length of the internodes forming the first fork; (6) the lengths of the two pairs of internodes forming the two second forks; (7) the lengths of ten of the younger internodes (all of the same age) near the ends of the branches; (8) the diameter of these ten internodes; and (9) the ratio between the length of the two branches above each of these ten internodes. In each type studied, a considerable number of plants were measured and the measurements averaged.

The various factor mutations were compared with the normal type (purple-flowered, spiny-fruited and many-noded). The white-flowered mutant was not found to differ appreciably from the normal type. The smooth-fruited form, however, has significantly narrower angles, shorter internodes, greater stem diameter and greater difference between the two branches at a fork than does the spiny-fruited one; and the few-noded type has a significantly shorter trunk, shorter internodes, narrower stem diameter and greater difference between the two branches at a fork than does the many-noded form. These constitute excellent examples of the manifold effects of a single factor upon the plant body as a whole.

Internally, few constant and characteristic differences between these mutant types and the normal form have as yet been distinguished, but in view of the notable differences in external structure it seems likely that a more complete and detailed anatomical study may reveal such differences.

An investigation was made of the gross external structure of several of the chromosome mutants with a single extra chromosome and each was found to display characteristic and significant differences from the normal type. Compared with the normal, "Reduced," for instance, shows a significant decrease in trunk length, angle width and stem diameter; "Cocklebur" an increase in angle width and a decrease in stem diameter and in internode length; "Globe" a decrease in internode length and an increase in stem diameter and in the difference in length between the two branches at a fork, and "Buckling" an increase in angle width.

Furthermore, a number of these chromosome mutants differ radically from the normal type in their internal structure. Both "Poinsettia" and "Wiry," for example, tend to have an asymmetrical central cylinder, and opposite the thin portions of the cylinder the cortex breaks open and produces a characteristic lesion. In these mutants wedges of wood also extend for some distance into the pith. In both "Cocklebur" and "Wedge," vessels are much more abundant than in the normal type and show a great variation in size. "Reduced" has a well-developed ring of sclerenchyma at the outer edge of the pith and the inner edge of the cortex. "Globe" tends to have thick-walled vessels, very round in cross section.

In "Buckling" the woody cells are very weakly lignified. Other distinctions will doubtless reveal themselves on a more intensive study.

Tetraploid plants from two distinct races were examined. Both showed an elongation of the trunk and an increase in the width of the first angle, the first pair of internodes and the stem diameter. Internally, the cells were found to be significantly larger than in the normal type and the woody tissue tended to be less strongly lignified.

Only a preliminary survey of the field has as yet been made. The authors believe, however, that these *Datura* cultures provide exceptionally promising material for a study of the effect of specific factors and of specific chromosomes, particularly upon structural characters; and they hope through further investigation to be able to contribute materially to a factorial analysis of the chromosomes of this species.

¹ Paper presented before the Botanical Society of America, December 28, 1921.

² Albert F. Blakeslee, "Types of Mutations and Their Possible Significance in Evolution," *Amer. Naturalist*, **55**, 1921 (254-267); and "Variations in *Datura* Due to Changes in Chromosome Number," *Ibid.*, Jan.-July, 1922.

THE RIEMANN GEOMETRY AND ITS GENERALIZATION

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1. One of the simplest ways of generalizing Euclidean Geometry is to start by assuming (1) that the space to be considered is an n -dimensional manifold in the sense of Analysis Situs, and (2) that in this space there exists a system of curves called *paths* which, like the straight lines in a euclidean space, serve as a means of finding one's way about.

These paths are defined as the solutions of a system of differential equations,

$$\frac{d^2x^i}{ds^2} + \Gamma_{jk}^i \frac{dx^j}{ds} \frac{dx^k}{ds} = 0, \quad (1.1)$$

in which the Γ_{jk}^i 's are analytic functions of (x^1, x^2, \dots, x^n) and the indices i, j, k run from 1 to n . The second term is a summation with regard to j and k in accordance with the usual convention in such formulas that any term represents a summation with respect to each letter which appears in it both as a subscript and as a superscript.

Since the second term is a quadratic form in $\frac{dx^i}{ds}$, there is no loss of generality in assuming, as we do, that

$$\Gamma_{jk}^i = \Gamma_{kj}^i \quad (1.2)$$